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SEISMIC PERFORMANCE OF FLAT SLAB WITH DROP AND CONVENTIONAL SLAB STRUCTURE

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Abstract: The provision requires structural engineer to perform linear static analysis for the design of a structure. Displacements, storey shears and overturning moments are the major factors that cause severe building damages due to earthquake. In the present work RCC flat slab structure and conventional slab structures are considered for comparative study of 6 storey building which is situated in earthquake zone-II and for earthquake loading, the provisions of IS: 1893 (Part1)-2002 is considered. A three dimensional modeling and analysis of the structure are carried out with the help of E-tabs 2015 software. Linear Static Method of Analysis and Response spectrum analysis method are used for the analysis of both Flat slab structure and Conventional slab structure.

The forces and all the relative displacements, storey shears and overturning moments that are developed in each of the structure are analyzed. The results that are obtained from the analysis are discussed. Further these results have been used for understanding the performance of flat slab structure and conventional slab structure under the effects of lateral loads and earthquake.

The results are compared and found that flat slab structure perform well in earth quake condition than the conventional slab structure.

Keywords: Displacements, Storey Shears, Overturning Moments, Linear Static Analysis, Lateral Loads.

1. INTRODUCTION

Earthquake is a phenomenon that occurs due to the geotechnical activities in the strata of the Earth and is highly unpredictable and causes heavy losses to both life and property if it occurs in populated regions. Earthquake does not kill humans, but the buildings do. Thus, it is the prime responsibility of a structural (design) engineer to draw out the parameters from previous experiences and consider all the possible hazards that the structure may be subjected to, in future, for the purpose of safe design of structure.

There are many available techniques for the analysis of the structure and to evaluate their performance under the given loading, the most accurate among them being the Non-Linear Time history Analysis. For the structures with less importance or seismic hazard, some other conventional methods have been developed called as Non-Linear Static methods (NSPs). The results obtained from these procedures may or may not be accurate.

In general slabs are classified as being one-way or two-way. Slabs that primarily deflect in one direction are referred to as one-way slabs. When slabs are supported by columns arranged generally in rows so that the slabs can deflect in two directions, they are usually referred to as two way slabs. Two way slabs may be strengthened by the addition of beams between the columns, by thickening the slabs around the columns (drop panels), and by flaring the columns under the slabs (column capitals)

Flat plates are solid concrete slabs of uniform depths that transfer loads directly to the supporting columns without the aid of beams or capitals or drop panels. Flat plates can be constructed quickly due to their simple formwork and reinforcing bar arrangements. They need the smallest overall storey heights to provide specified head room requirements. And they give the most flexibility in the arrangement of columns partitions. They also provide little obstruction to light and have high fire resistance there are few sharp corners where spalling of concrete might occur. Flat Plates are probably the most commonly used slab system today for multi-storey reinforced concrete hotels, apartment's houses, hospitals and dormitories.

Flat plates present a possible problem in transferring the shear at the perimeter of the columns. In other words, there is a danger that the columns may punch through the slabs. As a result, it is frequently necessary to increase column sizes or slab thickness or to use shear heads. Shear heads consist if I or channel shapes placed in the slab over the columns. Although such procedures may seem expensive, it is noted that the simple formwork required for flat plates will usually result in such economical construction that extra costs required for shear heads are more than cancelled. For heavy industrial loads or long spans, however, some other type of floor system may be required.

Concrete slabs are often used to carry vertical loads directly to walls and columns without the use of beams and girders. Such a system called a flat plate is used where spans are not large and loads are not heavy as in apartment and hotel buildings.

Flat Plate is the term used for a slab system without any column flares or drop panels. Although column patter are usually on rectangular grid, flat plates can be used with irregularly spaced column layouts. They have been successfully built using columns or triangular grids and other variations.

Here, the floor slab is supported directly on the columns, without the presence of stiffening beams, except at the periphery. It has uniform thickness of about 125-250mm for spans of 4.5-6m. Its load carrying capacity is restricted by the limited shear strength and hogging moment capacity at the column supports. Because it is relatively thin and has a flat under-surface, it is called a flat plate, and certainly has much architectural appeal.

In design of flat plates, Flat Slabs it is assumed that the slab is divided into three strips in each direction. The outer strips are termed as column strips while the inner strip is termed as middle strip. In slabs without drops the width of the column strip should be half the width of the panel and in slabs with drops it should be equal to width of the drops. In case of slabs without drops, the width of the middle strip should be equal to half the width of the panel. For determination of Bending moment and Shear Force the method of analysis to be used is the Direct Design Method, The Equivalent Frame method.

2. LITERATURE REVIEW

The literature that is collected on this project is mentioned below and list of authors are also given below. The details will be presented in the seminar.

1. Apostolska et al., (2008)
2. Dhileep et al., (2011)
3. Sonipriya et al., (2012)
4. R.S. Deotale et al., (2012)
5. Joshi et al., (2013)
6. P.J.Salunke et al., (2013)
7. Mohammed Anwaruddin et al., (2013)
8. A.N Alzeadc et al., (2014)

2.1 Conclusion of literature review

Though much of the literature is available and many researchers have dealt with pushover analysis to investigate the behavior of the structures as per the governing earthquake codes of respective countries. But very less work has been done on comparison of flat slab with drop and conventional slab structure.
Hence the present study aims at evaluating the performance and comparing the analysis results of R C C structures, with conventional slab and flat slab with drop for different heights of plan regularity using ETABS.

2.2 Outline of Proposed Work

The main objectives of the study are as follows

1. To evaluate the seismic behavior of different regular RC moment resisting flat slab and conventional slab structure.
2. To evaluate base shear, storey displacement, overturning moments.

3. METHODOLGY

3.1 Dynamic Analysis

Dynamic analysis shall be performed to obtain the design seismic force, and its distribution in different levels along the height of the building, and in the various lateral loads resisting element, for the following buildings:

3.1.1 Regular buildings: Those greater than 40m in height in zones IV and V, those greater than 90m in height in zone II and III.

3.1.2 Irregular buildings: All framed buildings higher than 12m in zones IV and V, and those greater than 40m in height in zones II and III.

The analysis of model for dynamic analysis of buildings with unusual configuration should be such that it adequately models the types of irregularities present in the building configuration. Buildings with plan irregularities, as defined in Table 4 of IS code: 1893-2002 cannot be modeled for dynamic analysis.

Dynamic analysis may be performed either by the

i. Time history method
ii. Response spectrum method

3.2 Time History Method

The usage of this method shall be on an appropriate ground motion and shall be performed using accepted principles of dynamics. In this method, the mathematical model of the building is subjected to accelerations from earthquake records that represent the expected earthquake at the base of the structure.

3.3Response Spectrum Method

The word spectrum in engineering conveys the idea that the response of buildings having a broad range of periods is summarized in a single graph. This method shall be performed using the design spectrum specified in code or by a site-specific design spectrum for a structure prepared at a project site. The values of damping for building may be taken as 2 and 5 percent of the critical, for the purposes of dynamic of steel and reinforce concrete buildings, respectively. For most buildings, inelastic response can be expected to occur during a major earthquake, implying that an inelastic analysis is more proper for design.

However, in spite of the availability of nonlinear inelastic programs, they are not used in typical design practice because:

1. Their proper use requires knowledge of their inner workings, theories and design criteria.
2. Results produced are difficult to interpret and apply to traditional design criteria 3.The necessary computations are expensive.

Therefore, analysis in practice typically use linear elastic procedures based on the response spectrum method. The response spectrum analysis is the preferred method because it is easier to use.

The present work of the thesis is divided in to two phases. The first phase is to find out the Base Shear, overturning moments, Displacement and Time Period Performance of the structure undergoing the seismic behavior at zone-II of different storey levels of conventional slab structure. The second phase is to find out the Base Shear, overturning moments, Displacement and Time Period Performance of the structure undergoing the seismic behavior at zone-II of different storey levels of Flat slab structure.

3.3.1First Phase Methodology

1. The Building is assumed to be in Zone-II (moderate zone for Earthquake)
2. Analysis of Conventional Slab of Building using ETABS.
3. All building is being designed as per IS 456:2000 & IS 1893:2002.

3.3.2Second Phase Methodology

1. The Building is assumed to be in Zone-II (moderate zone for Earthquake)
2. Analysis of Flat Slab of Building using ETABS.
3. All building is being designed as per IS 456:2000 & IS 1893:2002.
4. Base Shear, overturning moments, Displacement and Time Period Performance of the structure undergoing the seismic behavior at zone-II of different storey levels were obtained.
5. Comparison of conventional Slab structure and Flat Slab Structure has been done in order to determine the difference between performances of both Slabs.

IV. ANALYTICAL DATA OF BUILDING

4.1 General

The main objective of performance based response spectrum analysis of buildings is to avoid total catastrophic damage and to restrict the structural damages caused, to evaluate the performance limits of the building. For this purpose response spectrum analysis is used to evaluate the real strength of the structure and it promises to be a useful and effective tool for performance based design.

4.2 Description of building Frames

In the present work, six storied (conventional and flat slab) reinforced concrete frame buildings situated in Zone II, is taken for the purpose of study. The number of bays in each direction and height at each floor are given below, the buildings is symmetrical about both the axis. The total height of the building is 18 for six storied. The building is considered as Special Moment Resisting Frame

.

4.3 Geometrical data of the structure

The conventional slab structure and flat slab Structure are considered to have the same geometrical data.

S.NO	VARIABLE	DATA
1	Number of stories	6
2	Number of bays in x-direction	4
3	Number of bays in y-direction	4
4	Bay length	5m
5	Height of the floor	3m

4.4 Preliminary data for the conventional slab:

S.No	VARIABLE	DATA
1	Type of structure	Moment resisting frame
2	Live load	3 kN/m^2
3	Floor finish load	1.0 kN/m^2
4	Wall load (external)	11 kN/m^2
5	Wall load(internal)	5.5 kN/m^2
6	Materials	Concrete (M25) and Reinforced with HYSD bars
7	Size of columns	350X350
8	Size of beams	230x300
9	Depth of slab	120mm thick
10	Specific weight of RCC	25 kN/m^3
11	Zone	II
12	Type of soil	Medium
13	Response reduction factor	5
14	Importance factor	1
15	Zone factor	0.10

4.5 Preliminary data for flat slab:

S.NO	VARIABLE	DATA
1	Type of structure	Moment resisting frame
2	Live load	3 kN/m^2
3	Floor finish load	1.0 kN/m^2
4	Materials	Concrete (M25) and Reinforced with HYSD bars(Fe500)
5	Size of columns	350X350
6	Depth of slab	150mm thick
7	Depth of drop	150mm thick
8	Specific weight of RCC	25 kN/m^3
9	Zone	II
10	Type of soil	Medium
11	Response reduction factor	5
12	Importance factor	1
13	Zone factor	0.10

5. RESULTS AND DISCUSSIONS

A six storied building with RCC structure with conventional slab and flat slab was analyzed in ETABS and results are obtained and calculating Displacement, Storey shear and Overturning moment compared as follows:

Structure 1: In this model I building with six stories is modeled as a "'RCC conventional slab structure". The dead loads are calculated by ETABS itself. The wall load is considered as uniformly distributed load on beams.

Structure 2: In this model II building with six stories is modeled as "RCC flat slab structure". The dead loads itself calculated by ETABS.

Model I & model II: RCC conventional slab structure and flat slab structure

Building is modeled as RCC conventional slab structure and flat slab structure. For the Analysis, a typical six storied structure with 4 bays in both X-direction and Y- direction with 5m bay length and a typical height 18m is considered.. The height of all the stories is taken as 3m. The column size is taken as 350mmx350mm for all the storey's, the beam cross section is taken as 230mmx300m.The floor slabs are modeled as membrane element of 120mm thickness for conventional slab structure and 150mm thickness for flat slab structure. The drop thickness is taken as150mm. All the supports are modeled as fixed supports. Linear static analysis is conducted on each of these models. The unit weight of concrete is taken as 25kN/m3., assuming steel in the reinforced concrete Fe 500 & M25.

5.1 Conventional slab structure

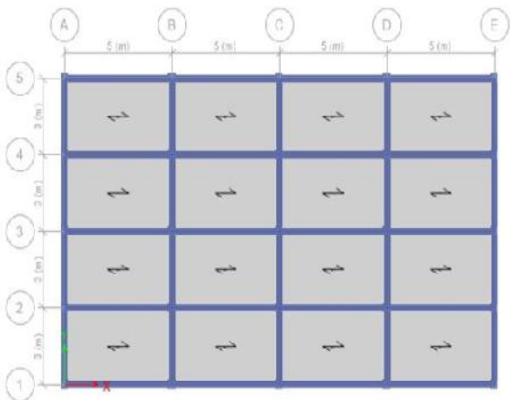

Fig 5.1 2D (plan) model of conventional slab structure

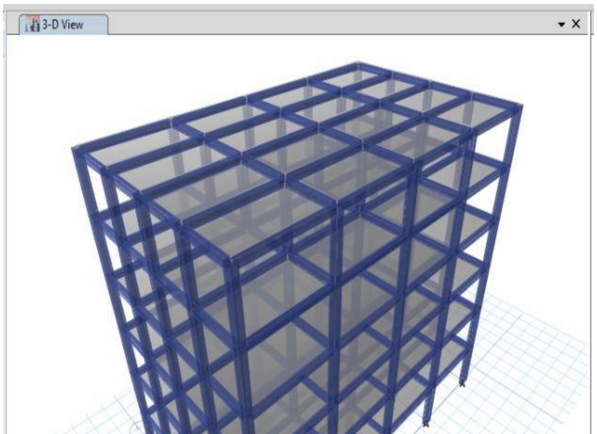

Fig 5.2 3D Model of conventional slab structure

5.1.1 Displacement of conventional slab structure

The maximum displacements at each floor level with respect to ground for equivalent static response. For better comparability the displacement for each model along the two directions of ground motion are plotted in as shown in Graph .In the three dimensional model, however, there are six degrees of freedom with the two translational degree of freedom along X, Y-axes and rotation degree of freedom about Z (vertical)-axis playing significant role in the deformation of the structure. Apart from the translation motion in a particular direction, there is always an additional displacement due to the rotation of floor. Due to this the maximum displacement at floor levels obtained by three-dimensional analysis are always greater than the corresponding values obtained by one-dimensional analysis. Moreover, the floor rotation is maximum at the top floor, gradually reducing down the height of the building to an almost negligible rotation at the lowest basement floor. In equivalent static analysis it has been found.

Table 5.1 displacement for conventional slab structure

DISPLACEMENT mm		
STOREY	EQX	EQY
6	7.3	6.2
5	6.8	5.7
4	6	5.1
3	5	4.2
2	3.8	3.2
1	2.3	2.1
0	0	0

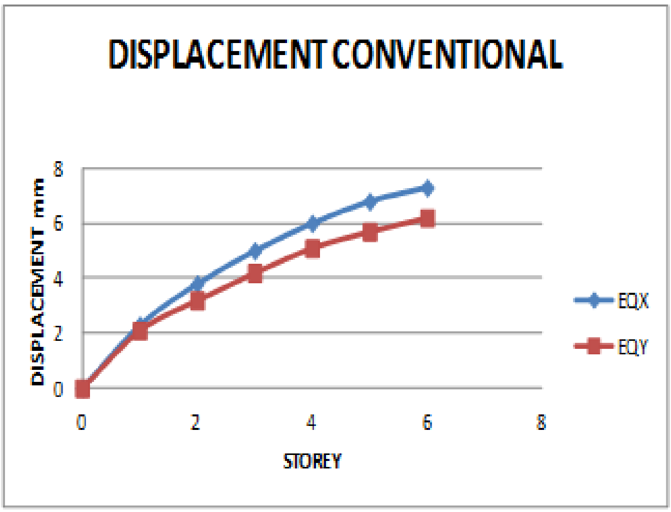

Fig 5.3 Displacement curve for conventional slab structure

In Table 5.1 we discuss the values of maximum static analysis of displacement in EQX and maximum static displacement in EQY at each storey of a six storied conventional slab structure which is decreasing as storey level is reducing and Figure.5.3 which is a graph comparing static analysis of displacement during earthquake in X-direction EQX and static analysis of displacement of earthquake in Y-direction EQY. We see that in graph static analysis displacement of earthquake in X-direction EQX is more than static analysis of displacement of earthquake in Y- direction EQY.
Since from above graph we can see that displacement is maximum in x-direction i.e., EQX. For example storey 6 EQX is 7.3mm whereas EQY is 6.2mm.

5.1.2 Storey shear for conventional slab structure

Storey shear is the sum of design lateral forces at all levels that are acting at the storey under consideration. As the storey shear is the sum of lateral forces, its value will increase with decrease in the storey under consideration.

Table 5.2 storey shear of conventional slab structure.

STOREY SHEARS KN		
STOREY	EQX	EQY
6	26.3771	30.9317
	26.3771	30.9317
5	46.6066	54.6541
	46.6066	54.6541
4	59.5534	69.8365
	59.5534	69.8365
3	66.8361	78.3766
	66.8361	78.3766
2	70.0728	82.1722
	70.0728	82.1722
1	70.8819	83.1211
	70.8819	83.1211
0	0	0
	0	0

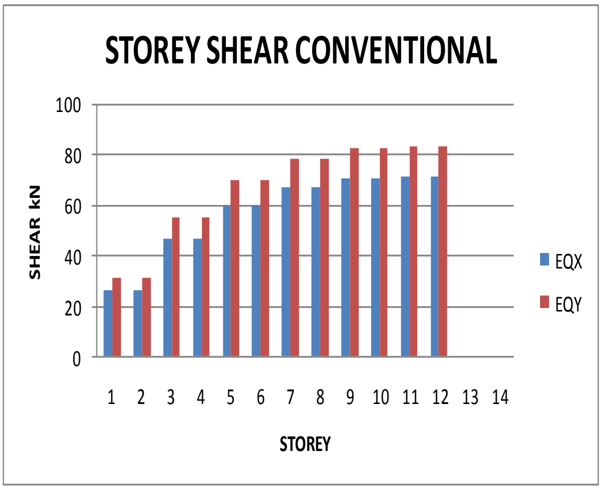

Fig 5.4 storey shear graph for conventional slab structure

In Table5.2 we discuss the values of maximum static analysis of storey shear in EQX and maximum static storey shear in EQY at each storey for a conventional slab structure which is decreasing as storey level is increasing and Figure.5.4 which is a graph comparing static analysis of storey shear earthquake in X-direction EQX and static analysis of storey shear of earthquake in Y-direction EQY. We see that in graph static analysis storey shear of earthquake in X-direction EQX is less when compared to static analysis of storey shear of earthquake in Y- direction EQY.

Since from above graph we can see that storey shear is maximum in y-direction i.e., EQY.

For example storey 6 EQX is 26.377 KN whereas EQY is 30.931KN .

5.1.3 Overturning moment

Table 5.3 overturning moment of conventional slab structure

OVERTURNING MOMENT KN-M		
storey	EQX	EQY
6	0	0
5	79.1314	92.795
4	218.9512	256.7573
3	397.6115	466.2668
2	598.1197	701.3965
1	808.338	947.913
0	1020.9838	1197.2761

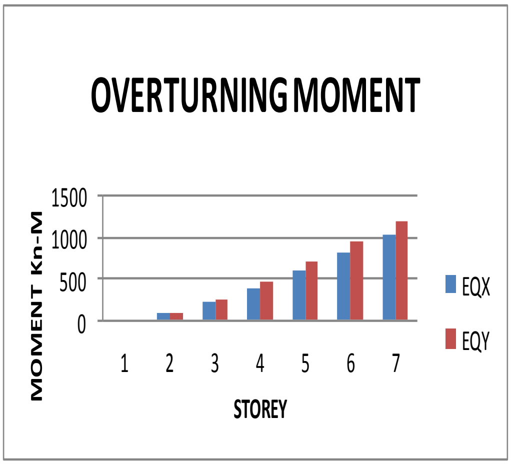

Fig 5.5 overturning moment graph for conventional slab structure

In Table 5.3 we discuss the values of maximum static analysis of overturning moment in EQX and maximum static overturning moment in EQY at each storey which is decreasing as storey level is increasing and Figure.5.5 which is graph comparing static analysis of overturning moment earthquake in X-direction EQX and static analysis of overturning moment of earthquake in Y-direction EQY. We see that in graph static analysis overturning moment of earthquake in X-direction EQX is less when compared to static analysis of storey shear of earthquake in Y- direction EQY.

Since from above graph we can see that overturning moment is maximum in y-direction i.e., EQY. For example base EQX is 1020.9838 kN-M whereas EQY is 1197.2761 kN-M.

5.2 Flat slab structure

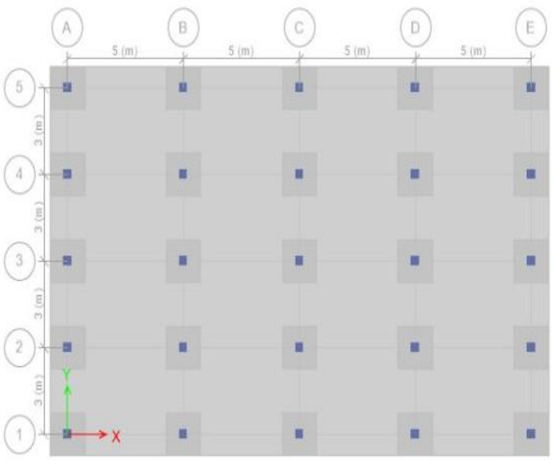

Fig 5.6 2D (plan) of flat slab structure

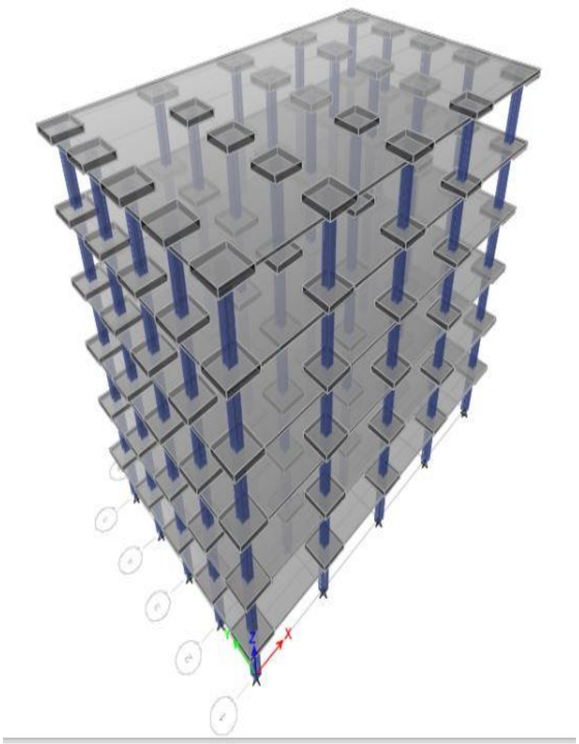

Fig 5.7 3D model for flat slab structure

5.2.1 Displacement of flat slab structure

Table 5.4 Displacement for flat slab structure

DISPLACEMENT mm		
STOREY	EQX	EQY
6	3.39	2.68
5	2.97	2.21
4	1.73	1.53
3	1.58	1.34
2	0.89	1.27
1	0.19	0.27
0	0	0

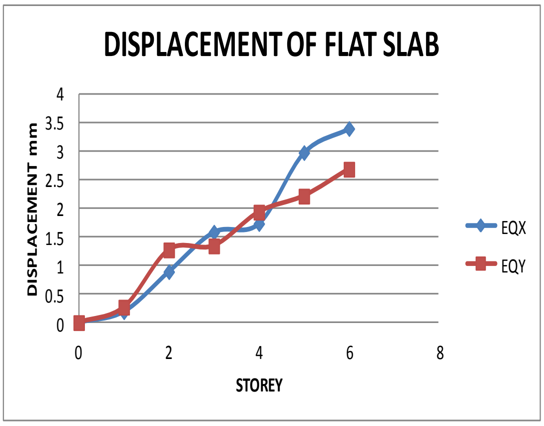

Fig 5.8 displacement curve for flat slab structure

In Table 5.4 we discuss the values of maximum static analysis of Displacement in EQX and maximum displacement in EQY for a flat slab structure, at each storey the displacement is decreasing as storey level is reducing and Figure.5.8 which is graph comparing analysis of displacement earthquake in X-direction EQX and analysis of displacement of earthquake in Y-direction EQY. We see that in graph analysis of displacement of earthquake in X-direction EQX is more than displacement of earthquake in Y- direction EQY.
Since from above graph we can see that displacement in flat slab is maximum in x-direction EQX when compared with displacement in Y-direction. For example storey 6 EQX is 3.39mm whereas EQY is 2.68mm.

5.2.2 Storey shear of flat slab structure

Table 5.5 storey shear of flat slab structure

STOREY SHEARS KN		
STOREY	EQX	EQY
6	11.609	11.6072
	11.609	11.6072
5	20.3247	20.3314
	20.3247	20.3314
4	25.9023	25.9158
	25.9023	25.9158
3	29.0392	29.0579
	29.0392	29.0579
2	30.4329	30.4551
	30.4329	30.4551
1	30.7811	30.805
	30.7811	30.805
0	0	0
	0	0

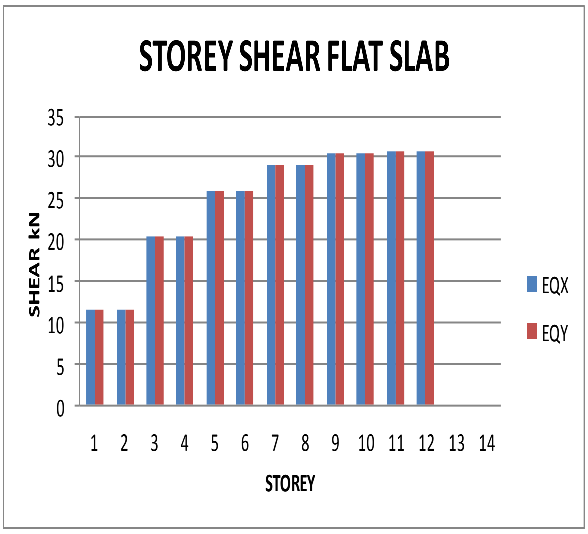

FIG 5.9 storey shear graph for flat slab structure

In Table5.5 we discuss the values of maximum static analysis of storey shear in EQX and maximum static storey shear in EQY at each storey for a flat slab structure which is decreasing as storey level is increasing and Figure.5.4 which is a graph comparing static analysis of storey shear earthquake in X-direction EQX and static analysis of storey shear of earthquake in Y-direction EQY. We see that in graph static analysis storey shear of earthquake in X-direction EQX is approximately equal when compared to static analysis of storey shear of earthquake in Y- direction EQY.
Since from above graph we can see that storey shear is approximately equal in both y-direction and x-direction i.e., EQY up to storey 5 and then it slightly increases in x-direction i.e; EQX. For example storey 6 EQX is 11.609 KN whereas EQY is 11.607 KN

5.2.3 Overturning moment of flat slab structure

Table 5.6 overturning moment of flat slab structure

OVERTURNING MOMENT KN-M		
storey	EQX	EQY
6	0.0021	0.0151
5	34.8314	34.8517
4	95.8075	95.8601
3	173.5172	173.6227
2	260.6368	260.8115
1	351.9376	352.1918
0	444.2807	444.6067

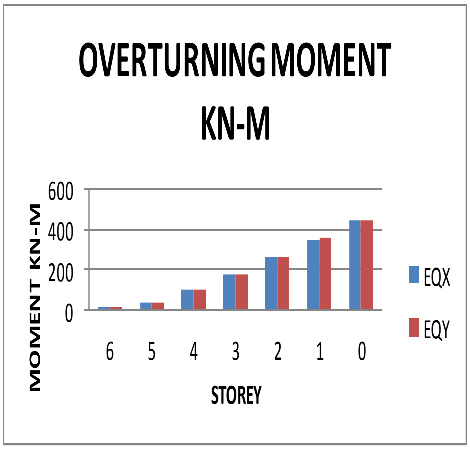

Fig 5.10 graph for overturning moment of flat slab structure

In Table 5.6 we discuss the values of maximum static analysis of overturning moment in EQX and maximum static overturning moment in EQY at each storey which is decreasing as storey level is increasing and Figure.510 which is graph comparing static analysis of overturning moment earthquake in X-direction EQX and static analysis of overturning moment of earthquake in Y-direction EQY. We see that in graph static analysis overturning moment of earthquake in X-direction EQX is less when compared to static analysis of storey shear of earthquake in Y- direction EQY.
Since from above graph we can see that overturning moment for flat slabs is maximum in y-direction i.e., EQY. For example storey 6 EQX is 0.0021KN-M whereas EQY is 0.0151 KN-M.

5.3 Comparison between conventional slab structure and flat slab structure
5.3.1Displacement

Table 5.7 Displacement comparison

DISPLACEMENT mm				
	EQX		EQY	
STOREY	CON	FLAT	CON	FLAT
6	7.3	3.39	6.2	2.68
5	6.8	2.97	5.7	2.21
4	6	1.73	5.1	1.93
3	5	1.58	4.2	1.34
2	3.8	0.89	3.2	1.27
1	2.3	0.19	2.1	0.27
0	0	0	0	0

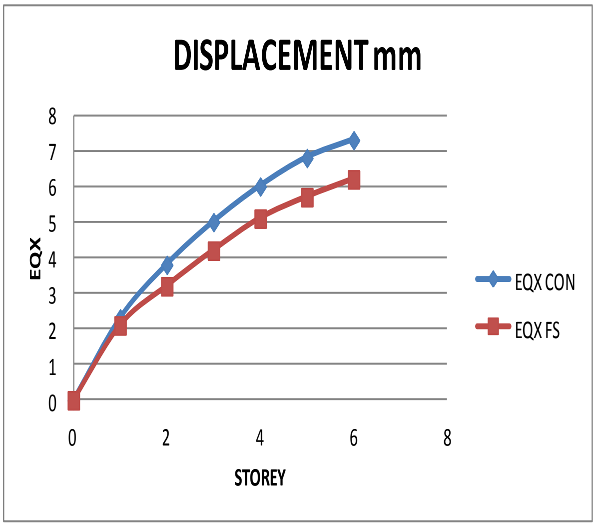

Fig 5.11Comparison graph for earthquake load in x-direction

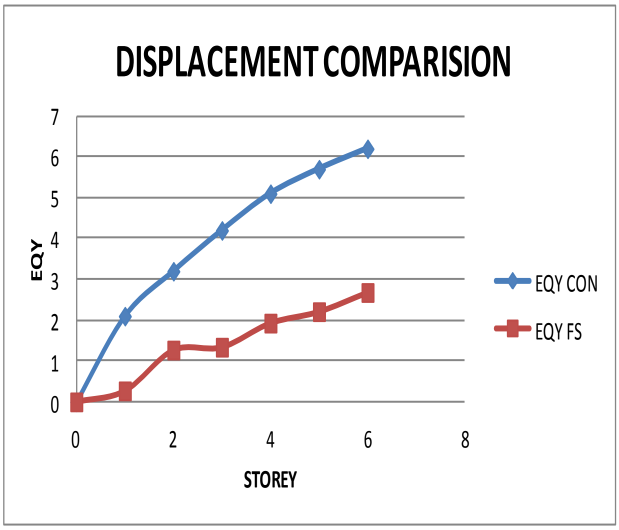

Fig 5.12 Comparison graph for earthquake load in y-direction

In table 5.7 we have discussed about the comparison of earthquake loading in both x- direction and y-direction of conventional slab and flat slab structure, and their respective graphs are drawn in fig 5.11 and 5.12. Figure 5.11 shows the comparison of earthquake loading in x- direction and figure 5.12 shows the comparison of earthquake loading in y-direction.

From the above table and figures we got to know that the displacements in conventional slab are more when compared with the displacements in flat slab structure for both earthquake loading in x- direction and y-direction. For example the value of displacement for storey 6 is 7.3mm and 6.2mm for conventional slab structure and 3.39mm and 2.68mm for flat slab structure.

5.3.2Storey shear

Table 5.8 comparison of storey shear

STOREY SHEARS KN				
	EQX		EQY	
STOREY	CON	FS	CON	FS
6	26.3771	11.609	30.9317	11.6072
	26.3771	11.609	30.9317	11.6072
5	46.6066	20.3247	54.6541	20.3314
	46.6066	20.3247	54.6541	20.3314
4	59.5534	25.9023	69.8365	25.9158
	59.5534	25.9023	69.8365	25.9158
3	66.8361	29.0392	78.3766	29.0579
	66.8361	29.0392	78.3766	29.0579
2	70.0728	30.4329	82.1722	30.4551
	70.0728	30.4329	82.1722	30.4551
1	70.8819	30.7811	83.1211	30.805
	70.8819	30.7811	83.1211	30.805
0	0	0	0	0
	0	0	0	0

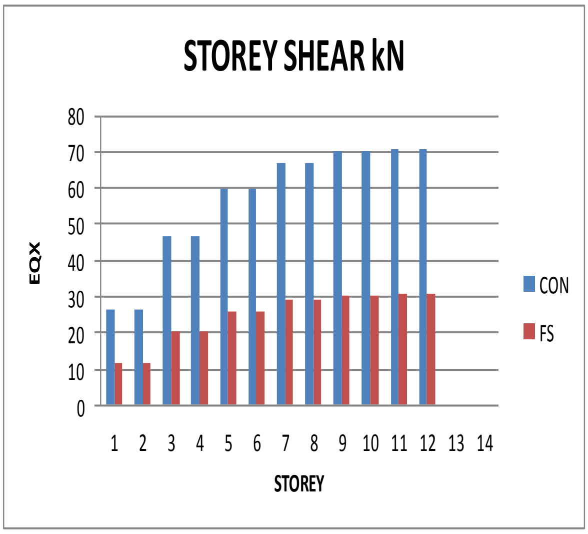

Fig 5.13 comparison graph of storey shear for earthquake load in x-direction

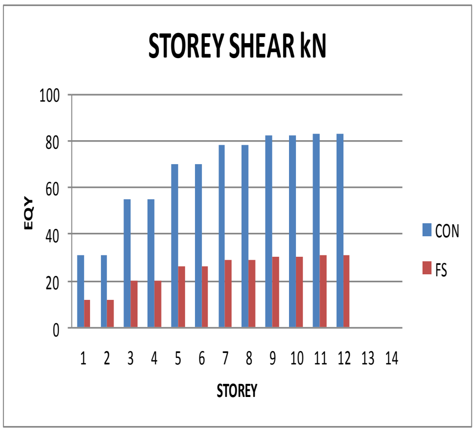

Fig 5.14 comparison graph of storey shear for earthquake load in y-direction

In table 5.8 we have discussed about the comparison storey shear of earthquake loading in both x-direction and y-direction of conventional slab and flat slab structure, and their respective graphs are drawn in fig 5.13 and 5.14.

Figure 5.13 shows the comparison of storey shear of earthquake loading in x- direction and figure 5.14 shows the comparison of storey shear earthquake loading in y-direction.

From the above table and figures we got to know that the storey shear in conventional slab are more when compared with the storey shear in flat slab structure for both earthquake loading in x- direction and y-direction. For example the value of storey shear for storey 6 is 26.3771kN and30.9317kN for conventional slab structure and 11.609kN and 11.6072kN for flat slab structure.

5.3.3 Overturning moments

Table 5.9 comparison of overturning moments

OVERTURNING MOMENT KN-M				
	EQX		EQY	
STOREY	CON	FS	CON	FS
6	0	0.0021	0	0.0151
5	79.1314	34.8314	92.795	34.8517
4	218.9512	95.8075	256.7573	95.8601
3	397.6115	173.5172	466.2668	173.6227
2	598.1197	260.6368	701.3965	260.8115
1	808.338	351.9376	947.913	352.1918
0	1020.9838	444.2807	1197.2761	444.6067

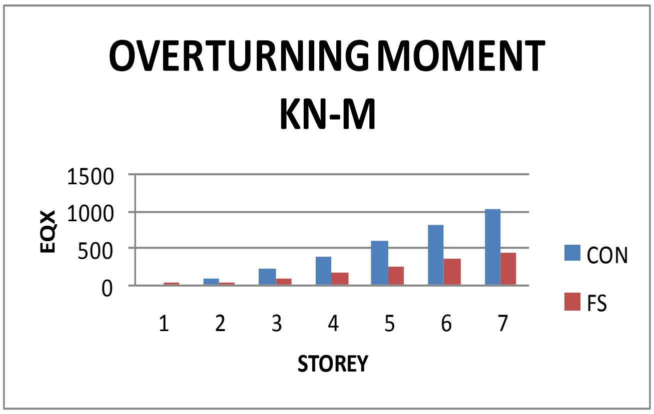

Fig 5.15 comparison graph of overturning moment for earthquake load in x-direction

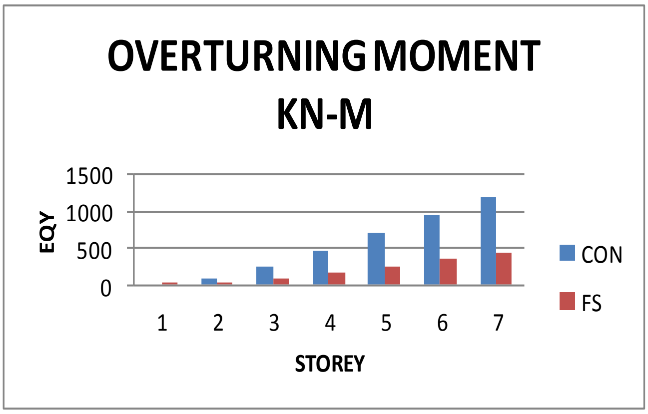

Fig 5.16 comparison graph of overturning moment for earthquake load in y-direction

In table 5.9 we have discussed about the comparison of overturning moment of earthquake loading in both x- direction and y-direction of conventional slab and flat slab structure, and their respective graphs are drawn in fig 5.13 and 5.14.

Figure 5.15 shows the comparison of overturning moment of earthquake loading in x- direction and figure 5.16 shows the comparison of overturning moment of earthquake loading in y-direction.

From the above table and figures we got to know that the overturning moment in conventional slab are more when compared with the overturning moment in flat slab structure for both earthquake loading in x- direction and y-direction. For example the value of overturning moment for storey5 is 79.1314kN-m and 92.795kN-m for conventional slab structure and 34.8314kN-m and 34.8517kN-m for flat slab structure.

5.4 Time periods for conventional slab and flat slab structure

Table 5.10 Time Periods

TIME PERIODS		
MODES	CON	FS
1	1.376	4.456
2	1.174	3.17
3	1.079	2.932
4	0.401	2.604
5	0.349	1.815
6	0.319	1.225
7	0.203	1.207
8	0.182	1.114
9	0.167	1.047
10	0.124	0.994
11	0.115	0.963
12	0.105	0.387

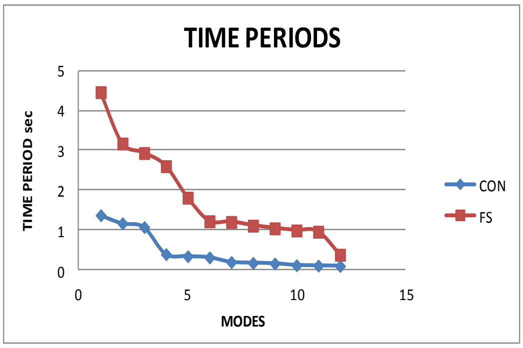

fig 5.17 graph of time periods

As shown in above graph it can be said that the time periods for conventional slab is more than the time periods for flat slab.

6. CONCLUSION

The following conclusions are made from the present study

1. The displacement is maximum in conventional slab structure when compared with flat slab structure.
2. The storey shear is maximum in conventional slab structure than in flat slab structure.
3. The overturning moments of conventional slab are higher than that of flat slab structure.
4. The time period of flat slab structure is less than the conventional slab structure.
5. In earthquake condition the flat slab structure will perform well for earthquake loads than the conventional slab structure.

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